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In every bag were thirty cats, and every cat had forty rats,
Besides a brood of fifty kittens. All *but* the nags were wearing mittens!
Mittens, kittens—cats, rats—bags, nags—Browns,
How many were met between the towns?

[*From Muttoon's Common Arithmetic.*]

Solutions to these problems should be received on or before December 1st.

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ALGEBRA.

Conducted by J. M. COLAW, Monteray, Va. All contributions to this department should be sent to him.

SOLUTIONS TO PROBLEMS.

15. Proposed by SETH PRATT, C. E., Assyria, Michigan.

From a point in an equilateral triangle, the distances to the angles are, respectively, 20, 28, and 31 rods. Required a side of the triangle.

II. Solution by G. B. M. ZERR, A. M., Principal of Schools, Staunton, Virginia.

Let the $\angle ACO=\phi$, and $\angle BCO=\theta$. Then, $28^2=31^2+x^2-62x\cos\theta$. $\therefore \cos\theta=\dfrac{177+x^2}{62x}$.....(1) $20^2=31^2+x^2-62x\cos\phi$. $\therefore \cos\phi=\dfrac{561+x^2}{62\phi}$....(2) also

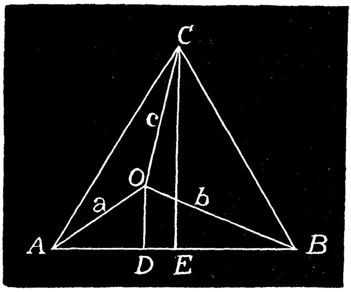
$$\cos(\theta+\phi)=\cos\theta\cos\phi-\sin\theta\sin\phi$$
$$=\cos 60^\circ=\tfrac{1}{2}.$$

$$\therefore \cos\theta\cos\phi-\sqrt{1-\cos^2\theta}\sqrt{1-\cos^2\phi}=\tfrac{1}{2}.$$

$$\therefore \cos^2\theta-\cos\theta\cos\phi+\cos^2\phi=\tfrac{3}{4}\ldots.(3).$$

(1) and (2) in (3) gives after reducing $x^4-2145x^2=-246753$.

$\therefore x^2=2023.02785$ or 121.97215.



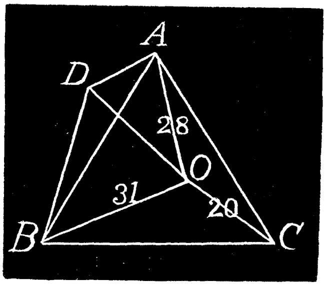
$\therefore x=44.97+$ or 11.045 according as the point is within or without the triangle.

III. Solution by J. K. ELLWOOD, A. M., Principal of Colfax School, Pittsburg, Pennsylvania.

Let ABC be the equilateral triangle, O the point within, $OC=20$, $OB=31$, $OA=28$. On OB construct the equilateral triangle OBD, and join AD.

In △s ABD and OBC we have two sides and included angle of one equal to the same in the other. $\therefore AD=OC$.

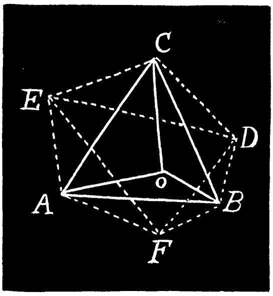
In △ AOD the three sides are now given, to find $\angle AOD$. Hence, $\cos AOD=\dfrac{31^2+28^2-20^2}{2\times31\times28}$ $=.77494=\cos 39^\circ\ 12'$.



The $\angle AOB=60^\circ+39^\circ\ 12'$. From the two sides and included angle of OAB we find $AB=\sqrt{31^2+28^2-2\times31\times28\cos(60^\circ+39^\circ\,12')}=44.97+$, the side required.

IV. Solution by J. W. WATSON, Middle Creek, Ohio.

Let ABC be the given triangle, o the given point. Put $Ao=a=28$, $Bo=b=20$ and $Co=c=31$. Let $S=$ a side of the triangle. Then area$=\frac{1}{4}S^2\sqrt{3}$.



Draw the $\triangle AFB=\triangle AoB$, $\triangle BDC=\triangle BoC$ and $\triangle AEC=\triangle AoC$. With A as a center and a as a radius describe the arc EoF. With B as a center and b as a radius describe arc FOD. With C as a center and c as a radius, describe arc EoD. Join EF, FD and DE. Now $\angle EAF=2\angle CAB=120^\circ$. Therefore, EF is equal to a side of an equilateral triangle inscribed in a circle whose radius is a.

$\therefore EF=a\sqrt{3}$. In same manner find $FD=b\sqrt{3}$ and $ED=c\sqrt{3}$. Area $\triangle EAF=196\sqrt{3}$, of $\triangle FBD=100\sqrt{3}$, of $\triangle DCE=240\frac{1}{4}\sqrt{3}$, of $\triangle EFD=823.18129+$. The area of the entire polygon $AFBDCE=1751.99357+$sq. rds. This is double the area of $\triangle ABC$.

$\therefore$ area $\triangle ABC=875.996785$ sq. rds. Equating the two expressions for the area, we have $\frac{1}{4}S^2\sqrt{3}=875.996785$. $\therefore S=44.97+$ rods, side of the triangle.

23. Proposed by ROBERT J. ALEY, A. M., Professor of Mathematics, Indiana University, Bloomington, Indiana.

Sum to n terms the following series: $11+25+45+71+103+\ldots\ldots$

I. Solution by B. F. BURLESON, Oneida Castle, New York, D. G. DORRANCE, Jr., Camden, New York, J. H. GROVE, Professor of Mathematics, in Howard College, Brownwood, Texas, and J A. TIMMONS, A. M., Professor of Mathematics in St. Mary's College, St. Mary's, Kentucky.

The first differences are 14, 20, 26, 32, ...;
the second differences are 6, 6, 6, ...;
the third differences are 0, 0, ...

Putting d_1, d_2, d_3 for the first terms of the differences we have

$$d_1=14,\ d_2=6,\ d_3=0.$$

Then, by the "Differential Method," we have, if we put a for the first term of the series, and S for its sum,

$$\begin{aligned}S&=na+\tfrac{1}{2}n(n-1)d_1+\tfrac{1}{6}n(n-1)(n-2)d_2,\\&=11n+7n(n-1)+n(n-1)(n-2),\\&=n^3+4n^2+6n=n(n^2+4n+6)=n[(n+2)^2+2].\end{aligned}$$

Similarly solved by *P. S. BERG, J. A. CALDERHEAD, H. W. DRAUGHON, J. H. DRUMMOND, J. K. ELLWOOD, A. L. FOOTE, M. A. GRUBER, ARTEMAS MARTIN, F. P. MATZ, COOPER D. SCHMITT, H. C. WHITAKER*, and *G. B. M. ZERR.*

II. Solution by J. F. W. SCHEFFER, Hagerstown, Maryland.

This is an arithmetical progression of the 2d order, in which $a=11$,